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Summary of June 2 Step-up Transformer Experiment Run

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Purpose: To verify efficient Wakefield energy coupling from stage I to stage II.

Experimental setup:

As shown in the next Figure

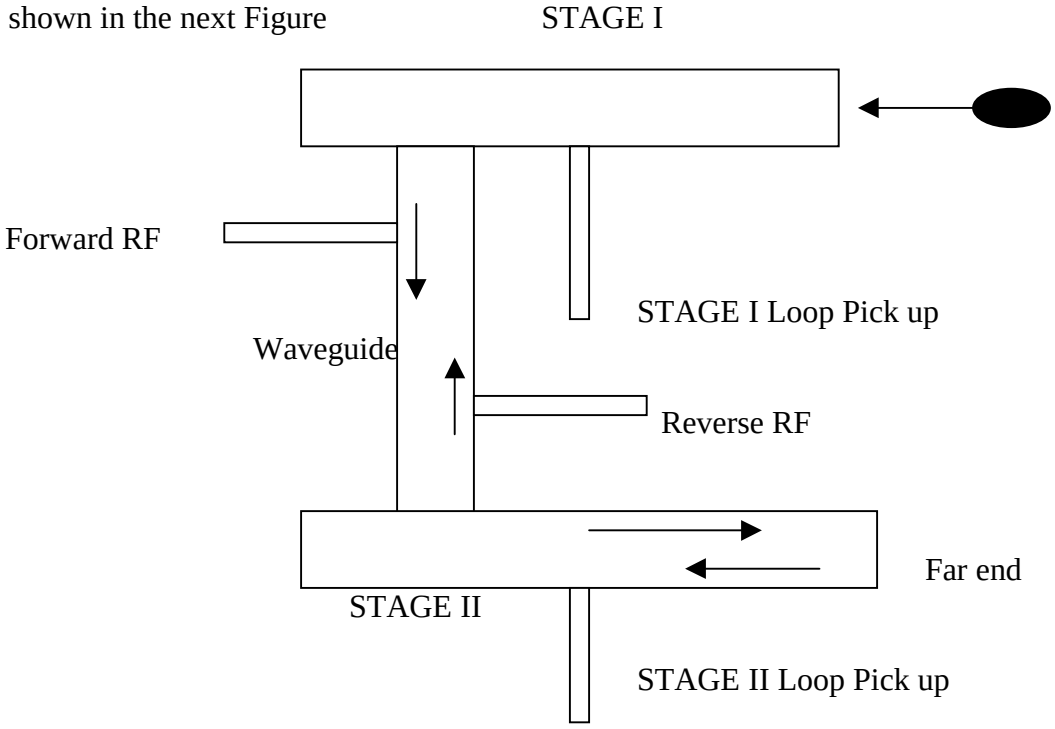

Figure 1: Experiment set-up.

We have generated a drive beam passing through this 7.8 GHz dielectric tube (20 – 30 nC). The WF generated in stage I tube is then extracted out to a rectangle waveguide. The expected RF power level is between 2 – 5 MW. Corresponding to the electrical field of 3 – 4.5 MV/m in the stage I. This WF power is then coupled into the stage II tube made with higher dielectric constant material and smaller sizes. If all the WF power from stage I can be transferred to stage II, then the peak field of stage II would be 2.5 times higher than the stage I.

Power measurements:

We measure the forward and reverse power flow through the waveguide as indicated in the figure. To be free of sourronding rf noise interference, we used a spectrum analyzer

to measure the relative power level of the forward and reflected powers. Ideally, the reflected power from stage II would be zero. However, we did not terminate RF at the far end, therefore the wakefield would be totally reflected. Due the dielectric and wall loss, the signal arrived at the reverse port would be much weaker.

From scope trace, we measured the peak forward rf power of ~ 4 MW.

Figure 2 shows the spectrum of the forward rf power and Figure 3 shows the reflected rf power. The data showed that the excited frequency us indeed 7.8 GHz as expected. The ratio of the forward and reflected power is ~ 3. Therefore we can safely assume that almost all the WF energy transferred from stage I to stage II. From physics point of view, we have demonstrated the principle of step-up transformer.

To be sure of power flow into the stage II, we have also measured the WF power spectrum from the rf pick loops. The data is shown in Figure 4 and 5. Power flow in the stage II tube was found and quantified. Although measured amplitude is 4 – 5 dB less than the measured in stage I, by using the calibration curve of this two coupling loops (stage II is 2 - 3 dB more attenuated) we found indeed most of the energy from stage I arrived in stage II.

Conclusion: By using the relative power spectrum measurement method, we have demonstrated the effective WF energy coupling from stage I to stage II, therefore demonstrated the principle of the step-up transformer. Using the 4 – 5 MW measured forward rf power, we can infer that gradient in the stage I of 4 – 5 MV/m and the axial gradient in the stage II would be ~ 8 - 10 MV/m.

Further experiment should be conducted, with particlular attention to the diode detectors calibration and noise reduction. Multiple pulse experiments also should be conducted to extend the WF pulses.

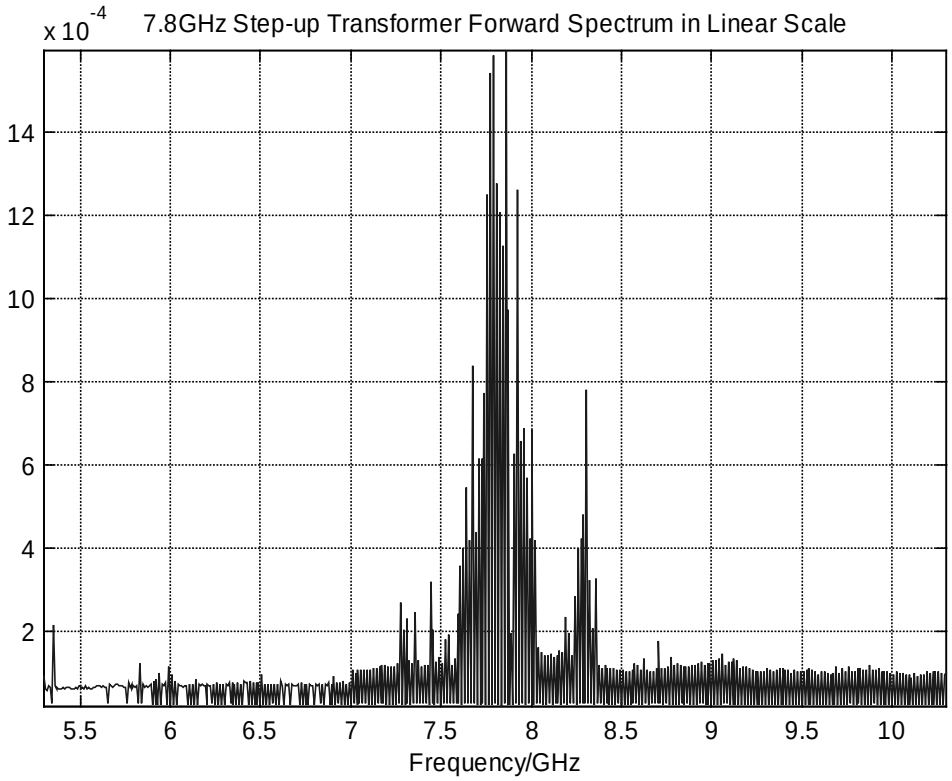

Figure 2 Measured forward RF power in Waveguide directional coupler.

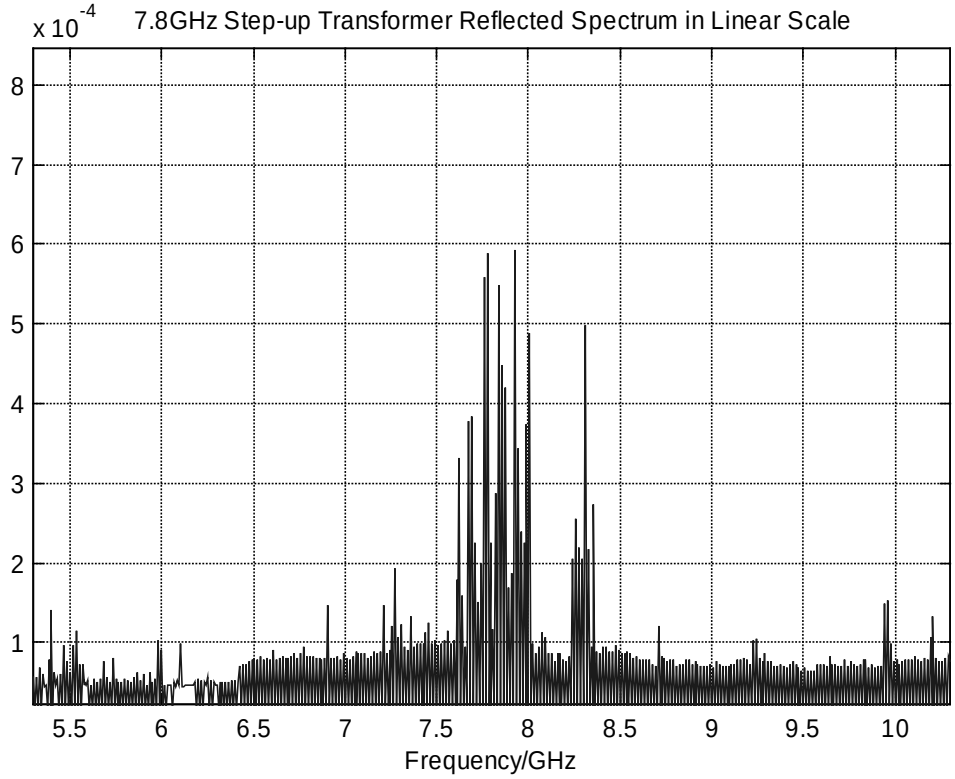

Figure 2 Measured reflected WF power at directional coupler

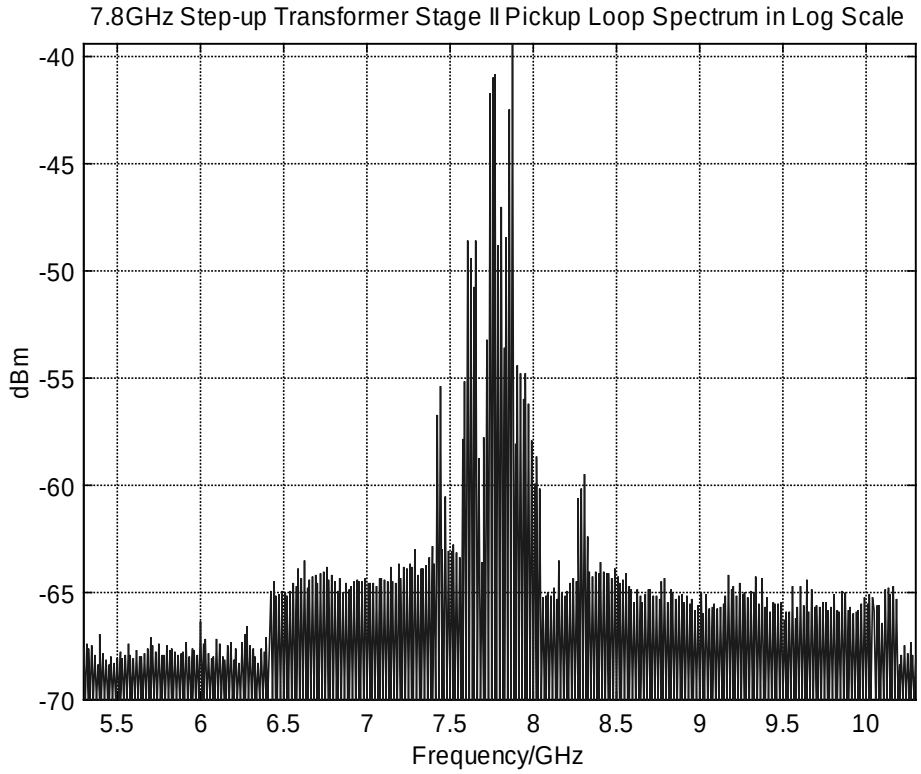

Figure 4. Measured RF energy flow in the stage II tube using an RF pick up loop.

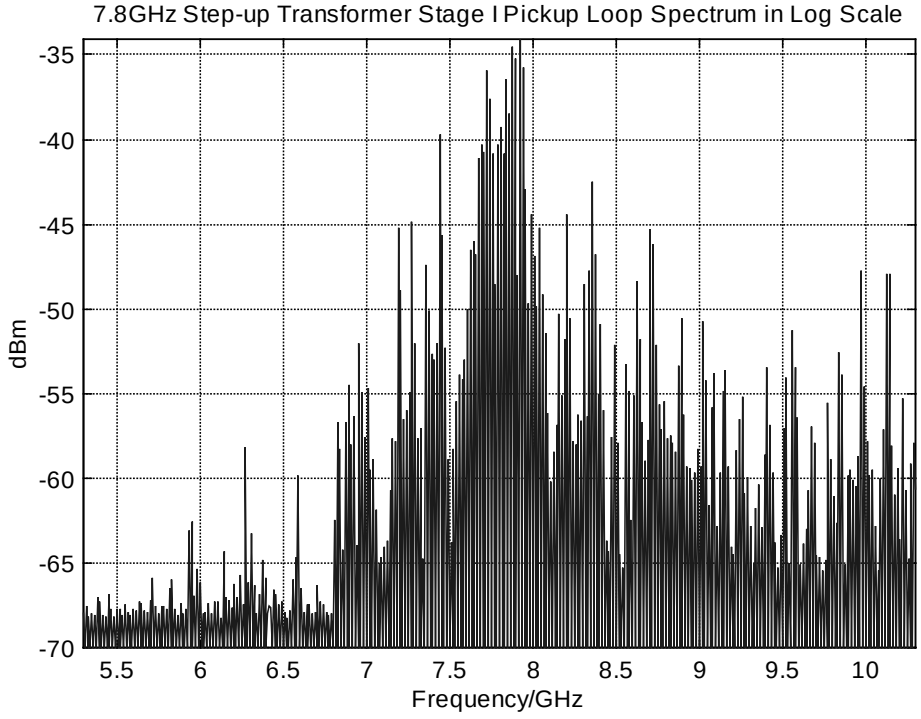

Figure 5. Measured RF energy flow in the stage I tube using an RF pick up loop.